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HENRY S. GRAVES, Forester

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CHOPPED SOAPWEED AS EMERGENCY FEED FOR CATTLE ON SOUTHWESTERN RANGES.

By C. L. Forsling, *Grazing Examiner.*

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THE NEED OF EMERGENCY FEED.

Heavy losses of stock resulting from long periods of drought are the greatest handicap of the stock industry on the ranges of the Southwest. Such droughts have occurred at intervals of from 3 to 10 years. When these droughts continue for more than a year the situation becomes critical because of lack of range forage or other available feed.

Cottonseed products serve well as supplemental feed in times when enough range forage is available to provide the necessary roughage. During prolonged droughts like the present one, which began early in 1916 and continues unbroken at the present time (June 15, 1918), the range forage crop may be so small as to require other roughage as well as concentrated feeds.

The problem may be solved in part in some of the less arid regions by raising fodder crops by dry farming. The ranges where this is practicable at present, however, are not extensive. On a few ranges, adjacent to irrigated districts, the necessary emergency feeds might be furnished by crops from such irrigated areas; but this supply at

best would be restricted to range in the immediate vicinity of the irrigated areas and would not provide emergency feed for the larger portion of the ranges of the Southwest, where losses have been heavy, and where breeding herds established through years of effort have been sacrificed.

In the hope of meeting the problem on such ranges, at least to an extent which will make it possible to maintain the breeding herd over critical periods, the Department of Agriculture for a number of years has been cooperating with a practical stockman on the Jornada Range Reserve[1] in southern New Mexico in working out a comprehensive plan of range management and supplemental feeding. For several years this plan has included investigation of the use of native vegetation as emergency feed. The results of range management with supplemental feeding, and of the initial tests to determine the value of soapweed as ensilage, were reported in Department of Agriculture Bulletin 588.[2] Later investigations, including extensive experimental feeding, have shown conclusively that soapweed, if properly utilized, is of great value as an emergency stock feed.

SOAPWEED AS RANGE FORAGE.

Soapweed (*Yucca elata*) is recognized as a valuable forage plant in its native state on the range. The green leaves are eaten during winter and spring, especially when a shortage of other forage exists. Ordinarily, the sharp points of the leaves discourage grazing, but where other forage is scarce cattle learn to chew the leaves from the center or base toward the sharp end. It is very difficult to estimate the exact food value of each plant, but where from 170 to 300 plants per acre are found no small amount of forage may be obtained from them. In the fall of 1917 a herd of cattle in southern New Mexico was maintained for at least two months on a range where the green soapweed leaves furnished 50 per cent or more of the forage. On an overgrazed pasture at a distance of 2 miles from water 47 per cent of the soapweed plants were grazed; and on closely grazed range 3 miles from water about 30 per cent were grazed. In many cases the entire leafage of soapweed plants was utilized.

The soapweed blossoms are of especially great value. The panicles of large white flowers appear on stalks commonly from 4 to 10 feet

[1] The Jornada Range Reserve is located in Dona Ana County, N. Mex., about 50 miles north of the Mexican boundary. It includes a range unit of approximately 200,000 acres. The average rainfall is less than 9 inches and varies from 3.5 inches to 15 inches.

Mr. C. T. Turney, the cooperating stockman, originated the idea of using the soapweed as a supplemental feed on the Jornada Range Reserve and was principally responsible for getting manufacturers to develop the machines which are now used successfully in chopping the soapweed.

[2] Jardine, J. T., and Hurtt, L. C., Increased Cattle Production on Southwestern Ranges, Bulletin 588, U. S. Department of Agriculture, 1917.

tall. Both the stalks and the flowers are palatable. The stalks begin to make their appearance early in May, and the stalks and flowers are good forage until late in June. Cattle thrive on them. Besides, they are so succulent that cattle grazing on them can go several days without water. This makes possible the use, for a short period at least, of range which otherwise might not be utilized on account of its great distance from water. The value of the bloom crop is increased by the fact that it occurs during a critical season when other forage usually is scarce and the stock is in poor condition. Without it, it would be difficult in many cases to carry the stock through until the summer rains. The main drawback is the uncertainty of a full crop. Large crops occur at intervals of several years, usually in the spring following a rainy autumn. However, some of the plants bloom each year, so that a small annual supply can be depended upon.

The young leaves or growing tips of the soapweed stems also are valuable for forage immediately after growth has started in the spring. It is common to see a cow go from one plant to another biting out the center or growing tips.

The value of soapweed as stock forage in its native state on the range makes it desirable, other things being equal, to use range supporting the heaviest stands of soapweed during the winter and spring. This practice, of course, should vary so as to secure the maximum use of the most important forage plants on the area.

Close observation during the winter, spring, and early summer on closely grazed cattle ranges where soapweed occurs in any abundance will convince anyone that soapweed is valuable as a range forage plant. Even when grazed to the best advantage, however, it does not adequately meet the requirements of an emergency feed. The nourishment obtained from grazing the leaves alone is not sufficient to tide an animal over for more than a very short period, and drought may make it necessary to give additional feed to stock long before the growth of the soapweed begins.

CUT SOAPWEED AS EMERGENCY FEED.

PRELIMINARY EXPERIMENTS.

Investigations to determine the practicability of cutting and feeding soapweed were begun at the Jornada Range Reserve in 1915. In December, 1915, approximately 150 tons of the heads and leaf portions were gathered and run through an ordinary ensilage cutter into a pit silo. In March, 1916, the silo was opened and about 10 tons of the soapweed ensilage was fed to poor cows over a period of several weeks. The results of the feeding were encouraging, although

the stock had difficulty in eating the ensilage (which they relished) because the cutter had not chopped the material fine enough.

The silo was opened again in January, 1918, and about 30 tons of the ensilage fed to poor cows, many of them suckling calves. About 15 pounds of a mixture of ensilage and cottonseed meal, in the ratio of 10 pounds to 1, was fed to each cow daily. The ensilage was in a good state of preservation, and the leaves had softened a good deal; but the fiber appeared to be about as tough as when the material was put into the silo in 1915. The feeding gave good results. The silo was closed again to save the remainder of the ensilage for emergency.

After the feeding of 1915–16, investigations were made to determine the food value of the stems and leaves of the soapweed plants. The following results of chemical analyses show that the material as a whole has a comparatively high food value.

Chemical analyses of soapweed (Yucca elata), compared with chemical analyses of important native range grasses of the same locality, on moisture-free basis.

	Soapweed.[1]		Black grama grass.[2]	Red three-awn grass.[2]
	Stems.	Leaves.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ash	8.4	6.7	7.4	8.2
Ether extract	2.0	3.6	1.4	1.1
Protein	4.25	8.2	4.6	4.8
Crude fiber	35.1	38.4	33.2	35.6
Nitrogen-free extract	50.25	43.1	53.4	50.3
Total	100.0	100.0	100.0	100.0

Chemical analyses of soapweed (Yucca elata), compared with chemical analyses of alfalfa, corn ensilage, and fresh green timothy, on moisture basis.

	Water.	Ash.	Ether extract.	Protein.	Crude fiber.	Nitrogen-free extract.	Number of analyses.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Soapweed stems[3]	54.7	3.6	1.1	1.3	15.2	24.1	2
Soapweed leaves[3]	42.3	3.6	3.1	4.5	22.3	24.2	2
Fresh green alfalfa[4]	74.7	2.4	1.0	4.5	7.0	10.4	143
Immature corn ensilage[4]	73.7	1.7	.8	2.1	6.3	15.4	121
Fresh green timothy[4]	62.5	2.2	1.2	3.1	11.7	19.3	88

[1] Average of four analyses made by the Bureau of Chemistry, U. S. Department of Agriculture, from samples submitted Sept. 10, 1917, Apr. 18, May 14, and May 31, 1918.

[2] Average of 24 analyses made by the Bureau of Chemistry, U. S. Department of Agriculture, from samples submitted each month beginning April, 1916, and ending March, 1918.

[3] Average of two analyses by Bureau of Chemistry, U. S. Department of Agriculture, from samples submitted May 14 and May 31, 1918.

[4] Analyses of alfalfa, corn ensilage, and timothy taken from "Feeds and Feeding" by Henry and Morrison.

The two native grasses, black grama grass (*Bouteloua eriopoda*) and red three-awn grass (*Aristida longiseta*) are the most important grasses on the Jornada Range Reserve, and yet the comparison is

slightly in favor of the soapweed. Although soapweed is considerably higher in crude fiber and ash than fresh green alfalfa, immature corn ensilage, and fresh green timothy, the comparison in the amount of ether extract (fat) protein, and nitrogen-free extract is favorable enough to indicate that the soapweed is a valuable feed so far as this is determined by chemical analysis alone.

Steps were taken also to secure a machine which would chop the plants finer, and several types of machines designed to cut the entire soapweed plant into material more suitable for feeding were put on the market early in 1918. One of these was installed at the Jornada Range Reserve January 13, 1918, and was there perfected to chop the plants satisfactorily.

SOAPWEED FEEDING ON THE JORNADA RANGE RESERVE IN 1918.

As a result of the prolonged drought the range forage crop on the Jornada Range Reserve in 1917 was far below normal. Consequently little range forage was left by January 1, 1918, and it was apparent that extensive feeding would be necessary to maintain a large percentage of the cows suckling calves and the cows heavy with calf. Accordingly, the feeding of chopped soapweed and cottonseed meal was begun January 20, 1918, with the object of preventing loss of cattle and maintaining the herd as cheaply as possible over the critical period until range forage became available. Riders were set to work gathering cows that were approaching a critical condition, and the number in the feed lot was increased daily. Soapweed feeding was still in progress June 15, 1918.

During the first 70 days of feeding an unsystematic effort was made to segregate the weaker cattle and feed them separately from the rest. Where a large number of cattle varying in condition are fed in one feed lot, the weaker ones are crowded away from the feed and will not improve in condition as they should.

Segregation was found to be important, and after the first 70 days the work was systematized so that the poorer cows were placed in a feed lot by themselves in small groups where they could receive individual attention if necessary, and were fed a slightly heavier ration than the main herd. After a short period of special attention and of feeding on the heavier ration, many of the poorer cows improved in condition and were put with the main herd on the lighter feeding.

It was found that the poorer cows when fed a daily ration of 25 pounds of the chopped soapweed and 3 pounds of cottonseed meal gained sufficiently in strength and condition in from 20 to 30 days to go into the main lot on a lighter ration. Stock in the main feed lot were fed a ration of from 15 to 20 pounds of the chopped soapweed and from 1 to 1⅓ pounds of cottonseed meal. After from 35 to 40

days on this ration about 85 per cent of the stock were put back on the range and fed 1½ pounds per day of cottonseed cake alone to supplement the dry grass and scattered browse forage available.

The number of cattle on feed varied from day to day. For the first 100 days the daily average was 340 head, varying from 500 head to 200 head for short periods following the return of stock from the feed lot to the range. More than 1,000 different individuals were in the feed lots between January 20 and June 1.

During the first 100 days approximately 306 tons of the chopped soapweed were fed, and feeding was continued at approximately the same rate up to June 1. The average period that individual animals were fed on soapweed and cottonseed meal during the first 100 days of feeding was 35 days. Some animals were fed during the entire period and others less than two weeks. After about 35 days of feeding on the soapweed and cottonseed meal the majority of the animals gained in strength and flesh sufficiently to warrant their being put back on pasture with a daily feeding of 1½ pounds of cottonseed cake.

No weights of cattle were taken to determine accurately the gains made as a result of the feeding. Under practical range conditions in time of drought, however, the measure of success in feeding is the percentage of cattle carried over the critical period without excessive cost and without the sacrifice of the breeding herd or a great reduction in the calf crop. It is estimated that without the soapweed feeding probably 50 per cent of the 1,000 head fed during approximately 150 days from January to June would have been lost. It might have been possible to save the other 50 per cent by a ration of cottonseed cake to supplement the scant range forage. As a result of the feeding the losses due to starvation from approximately 2,500 head were approximately 1 per cent for the 150-day period, and the breeding stock are in condition to produce a reasonably good calf crop provided the drought is broken by summer rains. Furthermore, the breeding stock on the reserve have been maintained at approximately the number the area will carry normally, and the efforts of years in building up the breeding herd have not been lost. Consequently, normal production of live stock will begin at once after the drought is broken.

On near-by ranges without provision for reserving pasturage or for extensive feeding, losses have been from 10 to 20 per cent during the first 150 days of 1918. In some cases where the range was overstocked the breeding stock have been sacrificed and material loss has been suffered both in the death of animals and in low market prices due to the poor condition of the stock.

The cost of feeding, as well as the success achieved in preventing losses, is influenced greatly by the ability of the riders who gather the animals. Careful riders accustomed to handling poor cattle sort

out only those animals which must be fed to prevent loss, so that unnecessary feeding of the stronger animals as well as unnecessary loss through failure to feed the weaker ones is avoided. Where a range is totally denuded of forage it is necessary, of course, to maintain the entire herd on the soapweed and cottonseed meal feeding. This, however, is rarely the case. More often the stronger animals can be maintained on the range without other feed; those not exceedingly poor and weak can be maintained by feeding from 1 to 2 pounds of cottonseed products daily to supplement the range forage; and only the weaker ones have to be fed the soapweed and cottonseed products.

SOAPWEED FEEDING ON OTHER RANGES IN 1918.

Stockmen throughout the Southwest have watched with interest the development of soapweed feeding, and many of them using ranges where conditions are similar to those of the Jornada Range Reserve secured machines to chop the soapweed and began feeding operations early in 1918. It is estimated that more than 100 herds varying from a few head to 1,000 head were being fed soapweed by June 1, 1918. In a few cases at least the soapweed was tried as a feed without cottonseed products. So far as observations went, however, the results were not entirely satisfactory, and cottonseed meal was added. This method of feeding has usually given good results, and there is no doubt that by it many thousands of cattle were saved from starvation during the first five months of 1918.

THE COLLECTION OF SOAPWEED.

BURNING AWAY DEAD LEAVES.

The dry dead leaves are very low in nutritive value, as is shown by chemical analysis, and are exceptionally high in crude fiber content, which makes digestion difficult. They are very dry and harsh and extremely unpalatable. It is desirable, therefore, to remove them before chopping the soapweed. This can be accomplished best by burning the dead portions from the plants while they are standing in the field, provided the vegetation on the ground is not enough to spread the fire. The dry leaves burn readily and in a short time, leaving uninjured the succulent stem and the green foliage at the top of the plant. One man with a torch working ahead of the men doing the cutting and hauling can burn the dead portions of from 8 to 15 tons of soapweed plants per day. A simple and effective torch may be made from a dead soapweed trunk from 12 to 18 inches long carried on an iron rod 5 to 6 feet long with a small hook at one end. Such dry, dead trunks are plentiful, light, and easily handled.

Burning can be done best on days when little or no wind is blowing, as high winds often extinguish the fire before the dead leaves are completely burned. No depreciation in the food value of the

plants appears to follow from standing several days after burning, and by burning several days ahead of the cutting, it is possible to avoid days when the wind is high.

Where there is danger of fire spreading over the range, burning should be done after the plants have been hauled to the chopping machine and arranged on the ground. To avoid undue shrinkage, the plants should be placed in rows two plants wide with the butts together and the green tops to the outside. This precaution prevents fire from becoming hot enough to burn the green leaves or succulent stem, and keeps the shrinkage down to about 30 per cent of the original weight. Where the plants are scattered thickly over the ground (Pl. II, fig. 2) burning results in a shrinkage of about 40 per cent, the increase being due to the fire's becoming hot enough to burn the green leaves.

SELECTING AND CUTTING THE PLANTS IN THE FIELD.

On the Jornada Range Reserve plants 36 inches or less in height were not cut, and occasionally plants tall enough for the seed stalks to be out of the reach of cattle were left for seeding. The plants under 36 inches were left on the range partly as a protection for the soil against wind erosion, partly because they furnish considerable grazing until the growing tips, seed stalks, and flowers are beyond the reach of cattle, and partly because small plants can not be handled in the feeding operations as economically as larger ones.

The plants were cut at the surface of the ground. Investigations are under way to determine whether this procedure should be modified in order to insure the production of new growth in the minimum time. After cutting, the new leaves begin growth just below the ground surface, and it may be necessary to leave a small portion of the stem above ground.

HAULING THE PLANTS TO THE CHOPPING MACHINE.

As the plants were cut they were loaded upon a wide rack and arranged in orderly rows, so as to make the most effective use of space and facilitate unloading. Both loading and unloading are done most conveniently by hand.

Where the feeding operations are on a rather extensive scale a crew can be kept cutting and hauling continually. A crew of four men with two 4-mule teams for hauling can work to good advantage. One man acting as foreman directs the operations, selects the plants for cutting, and burns off the dead leaves, if burning is done before the plants are cut. Two men with axes cut the plants and pass them up to a third man, who arranges them on the rack and drives the team. A crew of this size can select, burn, cut, and haul four loads, approximately 8 tons, per day where the haul is not over 2½ miles.

FIG. 1.—SOAPWEED PLANTS WHICH HAVE BEEN EXTENSIVELY GRAZED BY CATTLE ON AN OVERGRAZED RANGE.

Such general grazing of soapweed and stubby appearance of the plants are good indications that the range is overstocked.

FIG. 2.—BREEDING CATTLE BEING FED FROM 15 TO 20 POUNDS OF SOAPWEED WITH FROM 1 TO 1½ POUNDS OF COTTONSEED MEAL PER DAY TO MAINTAIN THEM THROUGH A DROUGHT AT THE JORNADA RANGE RESERVE.

Over 1,000 poor cows on the Reserve were fed between January 20 and June 15, 1918, and thousands of head were fed a similar ration on other stock ranches of the Southwest during the spring of 1918.

FIG. 3.—CUTTING AND LOADING SOAPWEED.

Four men with two wagons and eight mules can cut and haul 8 tons per day when the haul is not over 2½ miles.

FIG. 1.—SOAPWEED READY TO BE CUT FOR STOCK FEED.

The dead leaves have been burned off. One hundred and fifty plants, each averaging 35 pounds in weight, or more than 5,200 pounds of soapweed per acre, were cut from this area. It is probable that more careful selection in cutting should have been practiced so as to leave enough plants for protection against wind erosion. There are fewer young plants here than in the average stand over the range.

FIG. 2.—WHERE SOAPWEEDS ARE ARRANGED IN THIS MANNER AND BURNED TO REMOVE THE DEAD LEAVES, THE FIRE GETS TOO HOT AND BURNS PART OF THE GREEN LEAVES.

The loss in weight resulting from such burning on the Jornada Range Reserve was 42 per cent. Where the plants were arranged in rows two plants wide with the butts to the center, the loss in weight from burning was approximately 30 per cent. Burning on the range as shown in fig. 1 above is the most effective method where there is no danger of fire spreading and where there are but few young soapweed sprouts which may be killed by the fire.

THE PREPARATION OF SOAPWEED.

CHOPPING.

At least two types of machines have been developed to convert the stems and leaves into feed. One works on the principle of the ordinary feed chopper and cuts or slices the stems; the other works on the principle of the ordinary "wood hog" and shreds or tears the plant into particles small enough to be eaten readily by cattle.

The chopper has a heavy drumlike wheel, from 24 to 30 inches in diameter and from 12 to 14 inches wide, on the circumference of which are several heavy knives arranged to work against a cutter bar of heavy steel on the frame of the machine. The wheel makes from 250 to 300 revolutions per minute. It is mounted on a frame and is covered with a hood to prevent throwing off the cut particles of feed. The soapweed plants, after being lifted to the machine, are carried automatically over the cutter bar, and the knives chop the stem into particles somewhat resembling thin slices of pineapple. A 15 or 20 horsepower engine is required to operate successfully the larger machines first put on the market. The plants are fibrous and tough, so that power enough to maintain the cutting wheel at high speed is essential. These, when in proper order and when operated by experienced men, will chop from 25 to 30 tons of soapweed per day.

Three men are required to operate the chopper at full capacity. One man lifts the soapweed plants to the carrier of the machine, another places them in contact with the carrier, and a third clears the chopped feed away from the back of the machine.

The shredding machine consists of a heavy sheet-iron box approximately 16 inches wide, 16 inches long, and 36 inches deep, having at the bottom a small drum set with numerous tooth-edged knives. The soapweed plant is placed on end in the boxlike arrangement and with slight pressure from the hand of the feeder is forced to come in contact with the drum set full of teeth. This drum is rotated at a rate of 500 revolutions per minute, and the teeth coming in contact with the soapweed plant tear or shred it into small particles. This machine may be operated by two or three men, and requires an 8-horsepower engine. The capacity is much lower than that of the chopping machine.

Neither machine cuts the leaves of the soapweed very much, but both tear them apart enough for cattle to eat them.

MIXING SOAPWEED AND COTTONSEED MEAL.

The best way to mix cottonseed meal with soapweed is to sprinkle the meal over the chopped soapweed in successive layers as it is loaded into wagons to be hauled to the feed lot.

FEEDING WITH SOAPWEED.

HAULING TO THE FEED LOT.

A common wagon with a bed from 14 to 24 inches deep can be used for hauling the feed from the chopper to the feed lot. When the feed is lightly trampled an ordinary wagon bed 20 inches deep will hold from 1,400 to 1,800 pounds, or approximately 20 pounds to the cubic foot. With one team and wagon two men can haul 10 loads per day, so that they would be able to feed 1,000 cattle per day at the rate of 15 pounds per head per day. The chopped feed can readily be handled with the ordinary hay or manure fork.

METHODS OF FEEDING.

The best results have been obtained by feeding the soapweed in troughs or racks. It is possible to feed on hard ground, but at best this is wasteful. The troughs are most efficient when cottonseed meal is fed with the soapweed.

Substantial troughs 16 feet long, 4 feet wide, and 1 foot deep, which gives a large enough capacity to minimize waste, were found very satisfactory in the feeding operations at the Jornada Range Reserve. They were made of 2-inch yellow pine lumber, with bottom "tongued and grooved" to retain cottonseed meal, and were set upon substantial legs placed at each end and in the middle, bolted to the sides and securely braced and long enough to leave a space of 18 inches between the trough and the ground. This is high enough from the ground to eliminate most of the danger of the stronger cows hooking the weaker ones into the trough.

To get the best results enough troughs should be provided so that there will not be more than from 12 to 16 cows for each trough.

THE COST OF SOAPWEED FEED.

The cost of operations necessary in feeding soapweed, not including cost of cottonseed meal, on the Jornada Range Reserve was approximately $2.27 per ton. This figure is the cost after the men had become familiar with the work. At first it was about $2.75 per ton. The item of wages includes board.

The cost of each step is given below:

Burning, cutting, and hauling from range to chopper:		
1 foreman and burner, at $1.66 per day		$1.66
3 laborers, at $1.50 per day		4.50
8 mules (feed), at $0.50 per day		4.00
		10.16
Capacity per day, 8 tons.		
Cost per ton		$1.27

Chopping into feed:		
1 foreman, at $2 per day	$2.00	
3 laborers, at $1.50 per day	4.50	
Fuel (gas and oil), at $4.50 per day	4.50	
Repairs, etc., at $4 per day	4.00	
	15.00	
Capacity per day, 25 tons.		
Cost per ton		$0.60
Hauling from cutter to feed lot:		
2 laborers, at $1.50 per day	$3.00	
2 mules (feed), at $0.50 per day	1.00	
	4.00	
Capacity per day, 10 tons.		
Cost per ton		.40
Total cost per ton delivered to the feed troughs		2.27

THE COST OF A MAINTENANCE RATION.

The cost of cottonseed meal used at the Jornada Range Reserve in 1918 was approximately $63.50 per ton at the reserve. The cost of the soapweed was $2.27 per ton. At this rate a daily ration of from 15 to 20 pounds of the soapweed with from 1 to 1⅓ pounds of cottonseed meal cost approximately from $1.46 to $1.95 per head per month, which is a reasonable figure compared with the average cost of a maintenance ration of hay, even if hay were available.

This cost does not include the cost of machinery, nor depreciation on machinery, wagons, and equipment, nor any charge for the services of mules, nor the cost of riding to gather the poor cattle put on feed and to keep the poorest ones segregated from the rest in the feed lots. Most of these items will vary greatly and can be estimated best by the individual feeder for his intended operations. The riding will not be much greater than is ordinarily done to look after the stock in times when range is short, and most stock ranches have work horses or mules which would probably be idle if not used in the feeding operations.

A chopping machine of about 25 or 30 tons daily capacity and an engine to run it cost approximately $1,000 early in 1918.

THE TIME REQUIRED FOR CATTLE TO LEARN TO EAT SOAPWEED.

Little or no trouble has been experienced in getting poor breeding cattle to eat the chopped soapweed, and after they begin they relish it. Not a single animal among approximately 1,000 head fed on the Jornada Range Reserve seemed to dislike the feed or refuse to eat it at the first feeding. Feeding cottonseed meal with this highly palatable feed soon accustoms range cattle to the taste of

cottonseed products. This is of importance because range cattle placed on feed for the first time often require from 7 to 10 days before they are eating cottonseed products to advantage if the meal or cake is fed alone.

THE AMOUNT OF SOAPWEED CATTLE WILL EAT.

In the feeding at the Jornada Range Reserve it was found that poor breeding cows will be maintained or will improve slightly in condition on from 15 to 20 pounds of the soapweed feed and from 1 to 1⅓ pounds of cottonseed meal per day. This is a sufficient ration to maintain breeding stock over a period of drought. A mature animal if given all it wants of a mixture of 15 pounds soapweed to 1 of meal will eat about 50 pounds daily.

ILL EFFECTS FROM EATING SOAPWEED.

There is a slight danger from overfeeding with soapweed when stock are first put on feed, and some danger of choking. If cattle unaccustomed to eating the feed are supplied all they will eat the first few days, they may be affected by bloating, sometimes resulting in death. This bloating is not very noticeable and comes on quickly after a cow has overeaten. When death results it occurs very soon after bloating begins, and the animals seem to be in great pain for a short period. Loss of two cows out of more than 1,000 fed on the Jornada Range Reserve was attributed to this cause. Choking may result from the attempt of a cow to swallow too large a piece of the soapweed. Post-mortem examination of a cow that died apparently from starvation as a result of obstruction of the food passageway revealed a large piece of soapweed lodged in the esophagus at a point approximately between the lungs.

The danger of both bloating and choking can be overcome by proper management. Poor cattle that have been on short pasturage should not be allowed to overeat soapweed during the first few days. There is less danger after stock become accustomed to the feed. The danger from choking will be slight at most, and it can be avoided by the use of proper machinery to cut the plants into smaller pieces.

No bad purging or scouring effect, such as might be expected from the plant's soaplike qualities, resulted from feeding the soapweed. Cattle fed over 100 days, extending into the time when the sap had begun to rise or growth had begun in the plants, were not affected at all. Rather than ill effect there is an apparent good effect. Normally, stock on dry feed at this time of the year are badly constipated and doubtless would do better if given more purgative. It was found on the Jornada Range Reserve that the soapweed kept the digestive tract of the animals in excellent condition. There was a

slight effect of scouring on an occasional animal after the time the sap began to rise, but this was exceptional.

To determine any ill effects upon the digestive tract of the animal from feeding with soapweed, two range steers, one 4 and the other 5 years of age, were fed all the soapweed and cottonseed meal, in the proportion of 1 pound of meal to 15 of soapweed, that they would eat. One steer was fed for 65 days and the other for 87 days. The average daily consumption was slightly over 50 pounds. Both steers were butchered and carefully examined as to the effect of the feed on the digestive tract and on the meat. All the thoracic and abdominal viscera in both steers were normal. The fluidity of the viscera was marked, which may have been due in part to the ration of soapweed. The mucous membranes of the first, third, and fourth stomachs had a marked soapy appearance and touch. The fat was of good color and a firm consistency. The quality of the meat was first-class—tender and juicy. There was no evidence whatever, either in the meat or in the fat, that soapweed was the principal ration, and no impaction or other irregularity was found in the digestive tract.

FATTENING ON SOAPWEED AND COTTONSEED MEAL.

Of the two steers mentioned above, the one fed 65 days, a grade Angus, weighed 1,164 pounds on foot when butchered, having gained approximately 200 pounds in the 65-day period. The dressed carcass of this steer was 53.9 per cent of the live weight. The other, a native Mexico steer, weighed only 850 pounds and made no gain after the first 60 days of feeding. It dressed 52.9 per cent of the live weight.

The greatest value of soapweed is undoubtedly as an emergency-maintenance ration, and the available supply should be conserved for this use instead of being utilized for fattening purposes.

GROWTH HABITS OF SOAPWEED.

Soapweed (*Yucca elata*[1]), or "palmilla," as it is called by the Spanish-speaking people of the Southwest, is one of the most com-

[1] *Yucca elata* Engelm., according to Wooton and Standley (Contr. U. S. Nat. Herb. 19: 135. 1915), is distinguished from the other New Mexican yuccas (of which 8 species in all are listed) by its treelike habit, the naked woody stems in old plants attaining a height of "3 to 4 meters" (10 to 14 feet), by its narrow leaves (⅝ inch wide or less), and by its much-branched compound flower clusters.

Y. elata has long, slender, yellowish-green, flat, and fibrous-margined leaves, which readily distinguish it from the "Joshua tree" of southern California, southern Utah, and Arizona, *Yucca arborescens* Trelease (=*Clistoyucca brevifolia* (Engelm.) Rydb.). The leaves of *Y. arborescens* are short, stout, bluish green, concave above the middle, thickened, and minutely toothed; furthermore, the fruit of *Y. arborescens* is coated with a thin, dry pulp instead of being wholly devoid of flesh, the petals are much thicker, and the stigmas are not stalked.

The often treelike Mohave yucca (*Y. mohavensis* Sargent) of southern California and Arizona has leaves often about 2 feet long and 3 inches wide (much longer, wider, and

mon species of the yucca group of drought-resistant plants in the Southwest. It is one of the common plants on the dry plains and mesas from western Texas throughout southern New Mexico to southern Arizona, and extends into Mexico. It occurs commonly on the sandy soil which is the favorite habitat of the black grama grass (*Bouteloua eriopoda*), on which it reaches its maximum size in southern New Mexico. The stand on such areas may vary from a few to 300 plants per acre. Soapweed grows to some extent also on the clay flats and gravelly slopes adjacent to the sandy soil but does not reach its maximum stand on such areas. It is found only occasionally on the sandhill areas, probably because the unstable soil conditions make it difficult for the soapweed to establish itself there. Wherever it has become established on the sandhill areas, however, there is often produced a heavy stand. Further study is necessary, therefore, to determine the factors limiting distribution.

As is indicated by its occurrence in different habitats, soapweed will grow in sandy, gravelly, or heavy clay soil. It is not exacting in its moisture requirements. It commonly reaches 5 or 6 feet in height and sometimes grows as high as 30 feet on the plains where the annual rainfall is less than 9 inches. On the other hand, it has been found growing on the embankments of storage tanks at stock-watering places where the soil is very moist, and the growth seemed to be little or no different from that on drier areas.

Soapweed commonly reaches a height of from 4 to 6 feet, with a stem diameter varying from 3 to 6 inches. Occasionally, specimens reach a height as great as 30 feet and a diameter slightly greater than 6 inches. *Yucca elata* is different from most palm or grasslike plants in that the stem undergoes diameter enlargement after elongation, or height growth, has begun. This permits additional increase in volume and value of the plant aside from height growth, which is very slow after the plant reaches from 4 to 6 feet.

As in many other drought-resistant plants, growth in soapweed is very slow. At best the plant requires several years to reach the average height of from 4 to 6 feet. Judging from the growth of two-year-old plants, it will take about 10 years for new plants to reach a height of 36 inches or over, which now appears necessary

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stouter than those of *Y. elata*), and, moreover, its fruit is pulpy, the flesh often being nearly ½ inch thick.

Another Southwestern yucca that usually has a treelike form is Schott's yucca (*Yucca schotti* Engelm.), of southern Arizona and Sonora. Its leaves are flat except toward their concave tips, smooth, light yellow to bluish green, 16 inches to 3 feet long, 1 to 1½ inches wide, the thickened, untoothed margins finally breaking into short brittle threads. Other distinguishing characters are the hairy-woolly inflorescence and the late (October-November) ripening fruit, with its thin, sweet, pulpy coating.

Yucca macrocarpa (Torr.) Coville, ranging from western Texas to southern California, is distinguished by its long (up to about 3 feet), spiny, concave, yellow-green leaves, very early flowers (March and April), long-stalked stigmas, and oblong, blackish, fleshy, sweet, and edible fruits, 3 to 4 inches long, terminating in an abrupt point or terminal appendage.

for profitable cutting as cattle feed. There is little information on this point, however, and it will be several years before reliable data become available from growth studies begun in 1915.

Soapweed reproduces by sprouts from the roots of the old plants and from seed. The reproduction from seed is scant in comparison with the quantity of seed produced. Flower stalks make their first appearance about May 1 to 15 in southern New Mexico, and the period of blossoming extends from the last week in May to the latter part of June. After formation of the seed, the stalk and seed begin to dry slowly, and the pod opens in the fall, dropping the light, flat seed, which may be carried a considerable distance by the wind. The seed dissemination period often extends through the winter into the following spring, since the pods do not open fully at first.

Establishment of growth from seed is very slow, perhaps because of low vitality of the seed produced or of soil-moisture conditions unfavorable to germination and to establishment of the plants after germination. Reproduction by sprouts is more rapid. The sprouts spring up from the roots of the old plants the first growing season after the old stem is cut or dies. Often also new plants spring up from the base of old plants that are still alive, indicating that when old plants mature young ones spring up to take their places. Usually one or more sprouts spring up from a single old root, and it is common to find twice as many new plants on an area as there were old plants formerly. After the first or second year the growth of sprouts is perhaps not more rapid than the growth of seedlings.

NECESSITY FOR CONSERVATIVE, SELECTIVE CUTTING.

The growth habits of the soapweed make it important to observe several precautions in cutting the plant.

While soapweed is abundant on many ranges of the Southwest at present, the plant is very slow-growing and requires possibly 10 years to reach the size for profitable cutting. Consequently, indiscriminate and unlimited cutting would result in depletion of the supply in a comparatively short time. It is advisable, at least until further information is available as to the rate of growth of soapweed, that the soapweed should be used only for emergency feed to carry stock over a time of drought or for other emergency needs, such as feeding bulls during winters of average years if this is necessary to insure satisfactory bull service. As the droughts occur at intervals of from three to ten years, it should be possible to determine a rotation system of cutting, whereby sufficient soapweed will be available at any time for a drought that may last several years.

It has been found that areas of sandy soil which have been denuded of vegetation are often reduced to a sandy waste as a result of wind erosion. The heavy stand of soapweed undoubtedly is an important factor in bringing about and maintaining stable soil conditions favorable to the establishment and growth of grama grass and other important range forage plants. It is reasonable to suppose that should the cover of soapweed be removed by cutting on sandy areas, severe wind erosion would follow and result in range depletion and difficulty in reestablishing a cover of vegetation. Some system of selection in cutting whereby a sufficient number of soapweed plants will be left to serve as protection against wind erosion is advisable. This is very simple where cutting is for feed purposes. It is not profitable to cut plants below 36 inches in height for feed, and ordinarily more than 50 per cent or more of the plants on an area are under 36 inches in height. If these plants are left uncut, they will form a reasonably effective protection.

Ordinarily stock eat all the blooms within reach in the spring of the year, leaving only the tall plants to furnish seed. In order to permit natural seeding of areas barren of soapweed it will be necessary to leave some of these taller plants uncut.

The soapweed plants in their native state on the range have a value also as a protection to stock. The tall plants furnish shade to stock during the hot summer days, besides furnishing protection, especially for young calves, during cold rains and winds, which sometimes occur in the Southwest. It may be found advisable to leave plants to furnish such protection in addition to those left for seed plants. Restricting the use of soapweed to periods of drought and feed shortage should make it possible to plan the cutting so as to leave a sufficiently large number of plants on noncut-over areas to furnish shade and shelter.

If the plants below 36 inches on areas cut over are left uncut and if no more cutting is done than is necessary for emergency feed, the amount of feed obtained from grazing the blossoms, green leaves, and new growth of the plants will not be materially reduced. Consequently this source of forage can be relied upon as much as before cutting.

The extent to which plants above 36 inches in height can be removed without endangering the permanent supply of emergency feed and without injury to the forage cover or to soil conditions must be determined by further investigation. Owing to the slow growth of the plant, it will require a period of years to determine this with accuracy. In the meantime it will probably be safe to use the soapweed for feed if the suggestions given above about cutting are observed. As new methods are developed for converting the plants into stock feed, and as more information becomes available as to the

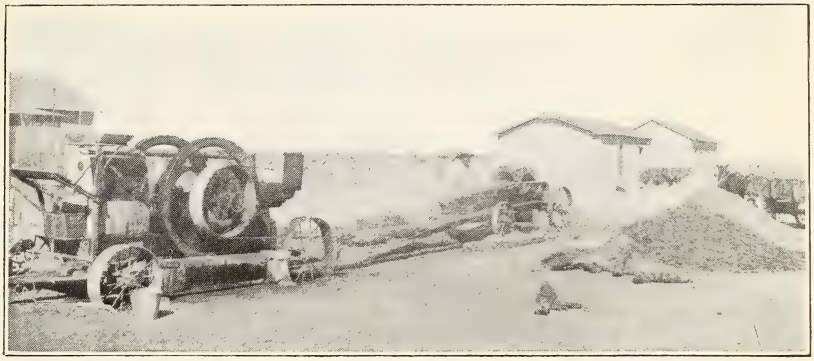

FIG. 1.—EQUIPMENT USED FOR CHOPPING SOAPWEED INTO CATTLE FEED.

Three men are required to operate this machine. The chopper cost from $300 to $550 and requires a 15 to 20 horsepower engine to operate it. Run at full capacity it will chop from 25 to 30 tons of soapweed per day.

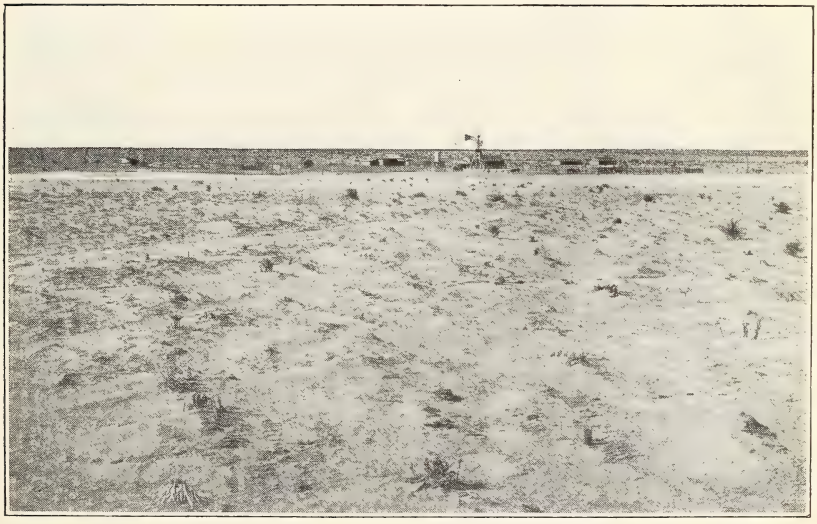

FIG. 2.—EFFECT OF WIND EROSION ON SOIL FOLLOWING THE REMOVAL OF SOAPWEED AND OTHER VEGETATION BY EXTENSIVE GRAZING AND TRAMPLING NEAR AN IMPORTANT WATERING PLACE.

The top of the root stumps was the former ground surface.

FIG. 1.—A HEAVY STAND OF SOAPWEED (YUCCA ELATA) AS IT OFTEN OCCURS ON SANDY SOIL ASSOCIATED WITH BLACK GRAMA GRASS (BOUTELOUA ERIOPODA).

Plants under 36 inches in height and occasional tall seed plants should be left when such areas are cut over. The young plants and a few older ones will serve as protection against destructive wind erosion and as protection for stock, besides insuring a second crop for cutting in perhaps 5 years.

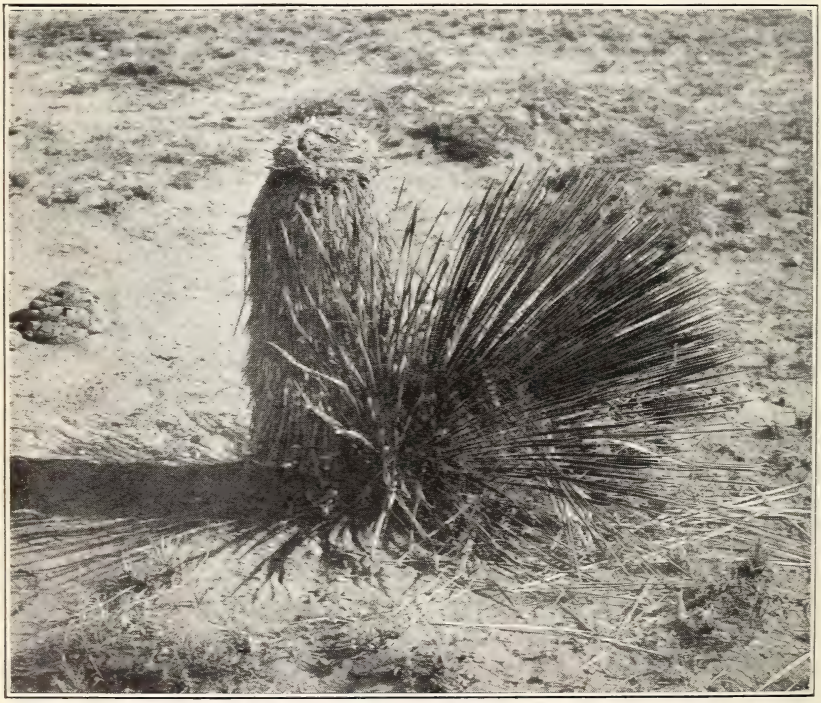

FIG. 2.—SOAPWEED SPROUT THE SECOND YEAR AFTER CUTTING OF THE OLD PLANT.

Indications are that it will require about 10 years for such young plants to reach average size for profitable second cutting.

growth habits of the plants and their value as a protection in building up and maintaining range, more extensive cutting for feed may be found practicable. On the other hand, more restricted cutting than is here recommended may be found advisable.

USE OF RELATED SPECIES.

SMALL SOAPWEED AND SACAHUISTA.

The possibility of making good feed from the leaf portions alone of plants like the soapweed suggests the use of small soapweed, or bear grass (*Yucca glauca*), which occurs north from central New Mexico, and sacahuista (*Nolina microcarpa*), which is found in southwestern New Mexico and southern Arizona, as well as *N. erumpens*, which occurs in western Texas. These often occur in considerable abundance. They do not, however, reach a height of more than 20 inches, and do not have a trunk or stem similar to that of the soapweed. They have been tried out as feed with fair success. The plants are chopped off at the ground, so that the leaves are separated from the rest. The leaves are then fed to the cattle. It is possible that this feed might be improved if made into ensilage.

SOTOL.

Sotol (*Dasylirion wheeleri*) occurs from western Texas to southern Arizona and *D. Texanum* in western Texas. Forage analyses and feeding experiments indicate that sotol is as valuable as soapweed when it is properly cut and prepared. It is more limited in quantity than the soapweed, however, since it is confined to the low mountains and foothills. Unlike the soapweed, it does not sprout again from the old root when cut. Furthermore, it is slower-growing than the soapweed, so that there will be an indefinite period after cutting before another stand is ready to cut.

SUMMARY.

Severe droughts which occur at intervals of from three to ten years have in the past caused severe setbacks to the range cattle industry in the Southwest through the greatly reduced crop of range forage during such periods and the lack of an economical feed as a substitute. A substitute, which is satisfactory to a large extent at any rate, has been found in soapweed (*Yucca elata*).

On the range soapweed is important as forage. Stock eat the leaves of the plant when other more palatable vegetation is scarce. The blooms and the growing tip in the center of the upper circle of leaves form an important part of the forage for cattle in the late spring and early summer.

Forage analysis has shown chopped soapweed to be comparable with native forage grasses and some of the poorer hay crops. The entire stem as well as the leaves can be utilized, and machines have been developed for chopping both stem and leaves into particles small enough to be eaten by cattle. As ensilage it is satisfactory, but the ensilage process is unnecessary where the soapweed is abundant. The chopped trunks or stems, which furnish the bulk of the feed, are palatable and, when fed with the chopped leaves, are readily eaten by stock without any softening process.

Results obtained on the Jornada Range Reserve, where more than 1,000 head of poor cows were fed in the spring of 1918 with very light losses, and results obtained on many other ranches in the Southwest to which the feeding practice spread rapidly, have demonstrated very clearly that the feeding of soapweed, with a supplemental ration of cottonseed meal or other similar concentrate, is practicable as a means of maintaining range cattle in time of drought.

The dead leaves should be removed before the plants are chopped. On the Jornada Range Reserve this was done by burning. If there is no danger of fire spreading, the burning can be done best while the plants are standing on the range. Otherwise, the burning should be done after the plants are hauled to the chopper. The reason for the removal of the dead leaves is that they are of low forage value and are unpalatable.

Plants over 36 inches in height should be selected for cutting. Those selected should be chopped off at the ground surface and run through a specially constructed machine which cuts or tears the entire plant into particles fine enough to be readily eaten by stock. This chopped feed mixed with a small amount of cottonseed meal or similar concentrate is fed to the stock, preferably in large troughs.

From 15 to 20 pounds of chopped soapweed with 1 to 1⅓ pounds of cottonseed meal daily will maintain the average breeding cow and may improve her condition slowly.

During 1918 the total operation in handling the soapweed from its native condition on the Jornada Range Reserve to the feed lot cost from $2.27 to $2.78 per ton, not taking into consideration the initial cost of machinery and equipment. With cottonseed meal at $63.50 per ton the cost of maintaining a cow on from 15 to 20 pounds of the mixed feed per day was from $1.46 to $1.95 per month, besides the cost of providing water and salt and of handling of the stock.

Where cows are very poor when placed on feed, it will probably be profitable to give them a larger ration for 20 or 30 days until they improve in condition sufficiently to be carried on the lighter ration without danger of loss. Stock that have improved on the lighter ration can probably be maintained at a slightly lower cost on a scant

grass or browse pasture and 1½ pounds of cottonseed cake per day, especially where securing labor is a difficult problem.

Poor cattle should not be fed all the soapweed feed they will eat the first few days on feed, since there is a slight danger of loss from bloating until they become accustomed to the feed.

Choking may occur as a result of a cow trying to swallow too large a particle of the soapweed. This is only occasional, however, and can be avoided by the use of a machine that cuts the feed properly.

There is no cumulative ill effect on the digestive tract of cattle fed on the soapweed over a long period. Neither is there any harmful purgative effect from the soapweed, except occasional scouring when feeding is continued after the sap begins to rise in the plant. On the contrary, the soapweed tends to keep the digestive tract of the animals in good condition. It is possible that the occasional scouring effect may be overcome by delaying the chopping of the plants into feed until they have been allowed to dry out for several days after the dry leaves are burned. This, however, is a suggestion only, as it has not been tried in practice.

The soapweed is found from western Texas to southern Arizona It reaches its average height and heaviest stands on the sandy soils usually occupied also by the black grama grass of the region. It is one of the slow-growing drought-resistant plants, and although it reproduces by sprouts from the old roots it probably requires 10 years for such sprouts to become tall enough for a profitable second cutting.

The soapweed has some value as a protection for cattle against storms and against the heat of the sun.

Soapweed is slow-growing, occupies a soil highly subject to wind erosion, and is a protection to stock, so that it is advisable to use the plant only as emergency feed. Only the larger plants should be selected for cutting, the smaller ones being left to protect the soil. Occasional plants tall enough for the blooms to be out of the reach of cattle should be left for seed plants and as a protection for stock.

Small soapweed, or bear grass (*Yucca glauca*), and sacahuista (*Nolina microcarpa* and *N. erumpens*) are somewhat similar to the soapweed, the small soapweed being found slightly farther north. It is possible that the greatest use of these plants for feed will be as ensilage.

Sotol (*Dasylirion wheeleri* and *D. texanum*) furnish feed for cattle about equal in value to soapweed when similarly chopped and prepared, but its limited distribution and slow reproduction restrict its importance as an emergency stock feed.

Methods of converting the soapweed into stock feed are not yet thoroughly developed, and will doubtless be improved upon. More data on the rate of growth, which it will take several years to acquire,

will make available information upon which to base a satisfactory cutting system. Further investigations may warrant modification in the present cutting practice either by extending or by restricting cutting. Meantime, however, it is believed that the soapweed may be cut for use as an emergency feed without any great damage to the range or danger of depleting the supply for emergency feeding if the suggestions contained in this bulletin relative to selective cutting are followed.

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